The University of Chicago

Everything's on Fire and it's (Sometimes) OK: Wildfire Mitigation Policy in the Front Range

By Morgan Simon

A thesis submitted for partial fulfillment of the requirements for a Bachelor of Arts degree in Public Policy Studies

Preceptor: Esther Ng
Faculty Advisor: Dr. Evan Carver

17 April 2023

Abstract

Wildfires pose a significant threat to communities and ecosystems, and effective policy measures are necessary to mitigate their impact. My thesis examines current policies and potential solutions to address the increasing wildfire risk, particularly as climate change worsens and makes the conditions for the perfect firestorm more common. My research question centers on whether the use of prescribed burns is an effective wildfire mitigation policy, focusing on Boulder County, in the Front Range of Colorado. Using a mixed-methods approach of both Geographic Imaging Service (GIS) data and interviews with firefighters, I explore the trends in fire conditions, and whether prescribed burns are effective and/or safe. I also touch on the potential benefits of incorporating Indigenous knowledge and practices into wildfire management policy. My findings suggest that prescribed burns, as they are currently employed, are largely ineffective, due to the increasing occurrence and severity of fire weather and decreasing public support. I recommend that there must be collaboration between government agencies, Indigenous communities, private industry, and individual homeowners. Only with the incorporation of Indigenous knowledge, innovative technology, and public education campaigns, alongside traditional measures such as prescribed burns and defensible space requirements, can there be a comprehensive and effective framework for mitigating wildfire risk.

Acknowledgements

There are many people without whose support this thesis would not exist. I would first like to thank my preceptor, Esther Ng, for her constant encouragement, support, and all the time she gave (and the early deadlines) to ensure that this thesis got done. Thank you for making sure procrastination didn't get us down. To Dr. Evan Carver, thank you for being my Second Reader, for your encouragement over this past year, and for understanding all my Colorado-specific references. You made this paper exciting to write. To my thesis group, you all gave so many good edits, feedback, and support throughout this entire process. I am so glad we got to go through this together.

To all the Public Policy faculty, particularly Chad Broughton, Jim Leitzel, and Maria Bautista, thank you for teaching me all I needed to know to write this paper successfully, and for all the support throughout my four years at the University. Milvia Rodriguez, thank you for always having time to chat, and for being an amazing advocate.

To my family and friends, each of you instrumental in proofreading, writing breaks, and encouragement, thank you all so much for believing in me from the beginning of this process. A special thank you to my friends and teammates on the swim team, who helped me proofread, kept me focused, and were always there to lend an extra pair of eyes. And Sarah Lewis, who's had my back since the very beginning, you're amazing, and I would not be here without you.

Mom and Dad, thank you for believing in me throughout all of college, for always being there for the difficult parts and the easy parts. It means so much that you have always had my back. I am so proud to be your daughter.

And finally, to the firefighters of the Mountain View Fire Rescue team, and all the stations across Colorado that came out on December 30th: without all the hard work you do, I would not have a thesis to write. Thank you for being willing to talk with me, for your honesty, and for all your hard work. It does not go unnoticed.

Table of Contents

Glossary of Terms

Controlled burns: prescribed fires, also known as prescribed burns, refer to the controlled application of fire by a team of fire experts under specified weather conditions to restore health to ecosystems that depend on fire.

Fire season: a period of time that originally spanned from May to September where fire-conducive conditions are far more prevalent.

Firewise Communities: communities are those that have taken appropriate measures to become more resistant to wildfire structural damage… Firewise techniques include minimizing the risk of home ignition by carefully landscaping around residential structures such as thinning trees and brush and choosing fire-resistant plants, selecting ignition-resistant building materials and positioning structures away from slopes. In addition, communities that have earned the special distinction of being recognized under the Firewise USA™ Program have followed a systematic approach to organizing and implementing a Firewise mitigation plan in their neighborhood.

Open space: undeveloped land that is protected from development by legislation.

Red-flag days: a red flag warning (or day) means warm temperatures, very low humidities, and stronger winds are expected to combine to produce an increased risk of fire danger.

The Front Range: a geological area extending from southern Wyoming to middle-southern Colorado that runs through the mountains and foothills. For this project, I will be focusing specifically on the area of the Front Range that is inside the bounds of Boulder County.

Traditional Ecological Knowledge: the evolving knowledge acquired by Indigenous and local peoples over hundreds or thousands of years through direct contact with the environment.

This knowledge is specific to a location and includes the relationships between plants, animals, natural phenomena, landscapes, and timing of events that are used for lifeways, including but not limited to hunting, fishing, trapping, agriculture, and forestry.

Wildland-urban interface: the WUI is the zone of transition between unoccupied land and human development. It is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

Preface

I grew up in a small town called Superior, located just outside of Boulder, right at the beginning of the Foothills that lead into the Flatirons. The outdoors have been a part of life there for as long as anyone can remember, with education about climate change, the environment, ecosystems, and green living being commonplace from kindergarten through senior year of high school. Part of that was explaining the necessities of fire in the West's ecosystem.

Fires are a normal, healthy part of life in Colorado. The heat from the flames helps many plants grow, and oftentimes, after fires, the grass grows back greener and less likely to carry a flame. It has only been in more recent years where the fires have gotten worse. Fires lasting for weeks, or even months, have occurred across the Front Range. And fire season – the time of year when fire conditions are at their peak – is expanding (Colorado Bureau of Land Management, n.d.).

In December 2021, I was home for Winter Break. It had been a restful break, though the weather had been abnormally warm, dry, and windy. It was the 30th, and I was getting ready to return to school for Winter quarter. My parents had gone out to get potting soil for a plant that had outgrown its pot (a Christmas cactus I had gotten my mom many years prior). Instead of getting to the store, they rushed home, talking about how "you could see the smoke," and how strange it was. They couldn't see over the bridge to our neighboring town. We went to the top of our hill and watched as flames raced across the grassy plains towards our town. The evacuation notice was sent out an hour later.

I remember driving through smoke and small pockets of flames to get to a friend's house, with visibility so bad that I could not even see the license plate of the car in front of me. My

family and I would stay with our friends for the next week. We spent all night wondering if our house would still be there, planning and preparing ourselves for the worst-case scenario.

On December 30th, 2021, the fire started in the open space — near Marshall Road in Boulder County, Colorado. What would come to be known as the Marshall Fire had begun. In less than 24 hours, it would expand to consume roughly 6000 acres, burn through two towns, destroy over 1000 homes, and kill two people. Barely a night after the fire started, a snowstorm would blow through over the mountains and help the firefighters quell the flames that were so impossible and dangerous to contain the day and night before.

When our town was finally opened back up to residents, each neighborhood entrance was guarded by a police officer or member of the National Guard. Our neighborhood was unrecognizable. Charred earth was all that remained of houses that had been there for as long as I could remember. The marsh in front of my house was blackened. There was no sign of the birds, foxes, rabbits, or coyotes that lived there.

The fire had reached all the way to our backyard. You could see the marks from a chainsaw where the firefighters cut down our fence to protect our house. We were lucky. But a thousand families were not.

Fire policy in the Front Range is a deeply personal topic for me. After all, fire is good. The large ones, the record breakers? Those are the ones that are dangerous. There must be a way to improve fire mitigation and control policy so that our ecosystem can recover, without the dangerous fires. There must be a way to make sure nothing like what happened to me happens to anyone else. There must be a way to live safely with fire, and if policy can be reformed and reexamined to strengthen it and provide firefighters with the support they need, then it would all have been worth it.

Introduction

The Marshall Fire is the most expensive fire in Colorado state history, and one of the largest fires to occur in a wildland-urban interface (where built-up land meets open space) in recent memory (Phillips, 2022; US Fire Administration, 2022). Unfortunately, it is far from the only large, record-breaking fire to have occurred in the past five years, with other fires like the Sunshine Canyon fire, and the Calwood fire – each incredibly expensive, intense, and destructive – burning thousands of acres of land each time. The state of Colorado has extensive fire mitigation policies in place, including encouraging new buildings to be built with fire-resistant materials, instituting burn bans, and employing prescribed burns – burns started intentionally with the goal of reducing future fire risk (US Forest Service, 2016). However, these large, intense, and difficult fires continue to occur, particularly along the Front Range, the stretch of land where the Great Plains meet the Rocky Mountains (Britannica, n.d.). When it comes to wildfire prevention, mitigation policy needs to evolve to match the increasing frequency and intensity of these fires.

Wildfire mitigation policy often includes complex, multi-level plans to remove undergrowth, protect open spaces, and place fire breaks where the wild lands back up against urban centers such as housing. Some of these plans do not consider the voices of people with extensive experience, such as Native people's generational knowledge, and that of firefighters, who interact with fire on the front lines. Despite the many strengths of wildfire prevention policy, by-and-large it does not include extensive input from those who see and interact with fire systems and the landscape daily. Firefighters, as people on the ground implementing mitigation policy, are those with the daily exposure and wealth of experiential knowledge. For instance, with prescribed burns, they may be the implementors, but they largely do not get control over

where, how, and when these burns take place. Instead, that is determined by supervising organizations and higher-ranking individuals who often do not see or interact with the land as frequently as firefighters do. Those higher-ranking officials make their decisions based solely on data and land surveys, which, while undoubtedly valuable information, does not include on-the-ground knowledge that is also vital to the decision-making process behind implementation.

Another factor that is not reflected in current Colorado wildfire mitigation policy is the input of Native organizers. There is an Indigenous group in California – the Indigenous People's Burning Network – that has done extensive advocacy work to ensure that Native Traditional Ecological Knowledge (TEK, the knowledge of the specific local environment gleaned through hundreds or thousands of years of interaction with the land) is reflected in fire policy, both for the conservation of their cultural practices and for the maintenance of their lands (US Fish and Wildlife Service, n.d.). These inputs have been shown to be largely successful in both restoring cultural practices and restoring the land (Buono, n.d.). While the landscape is different in California than it is in Colorado, by including more voices with historic knowledge of the land, wildfire prevention policy could begin to evolve to work with the changing climate and grow in effectiveness.

The year 2021 has not been the only devastating year for Western wildfires. As the years go on, more and more catastrophic wildfires are occurring due to worsening climate change and policy that has not evolved to account for that change. As the climate situation grows direr, it is becoming increasingly important to determine the best course of action for fire prevention and mitigation. Controlled burns are just one form of mitigation, but fears of out-of-control fires and threatened structures make their implementation difficult. In this paper, I am investigating controlled burns as fire mitigation policy, their effectiveness in the face of a changing climate,

and the increasing occurrence of large, intense, difficult-to-contain fires. I find that, unsurprisingly, controlled burns are becoming increasingly less effective, both because of the decreasing frequency of fire-safe weather and because of growing social stigma surrounding fires in Boulder County. Despite this, I find that fire is still necessary, and controlled burns cannot be effectively phased out of wildfire prevention policy due to their use in culturally and environmentally restorative effects.

Wildfire mitigation and minimization policy are commonplace in most Western states. There are many methods already in place to alert people of the risks of fires, including red flag warnings which alert people living in the surrounding geography to the heightened level of fire risk and fire bans, which signal that the fire risk is high or that open flames are banned (US Department of Commerce, n.d.). Oftentimes, these alerts are displayed on notice boards above busy streets or on weather apps and websites. These are constant reminders that the risk of a Wildland Urban Interface fire (where open space meets built-up areas), or WUI fire, is ever present, especially along the Front Range.

The last two years alone saw the three largest wildfires in Colorado's history, (Colorado Division of Fire Prevention and Control, n.d.; The Denver Post, 2016) and experts in the field often say that wildfires are not *caused* by climate change and global warming, but the effects of climate change – including drier plants, droughts, high winds, and warmer weather – make wildfires more likely and more dangerous (Booth, 2022). All these factors lead to more frequent perfect firestorm days, days and symptoms which helped to cause the Marshall Fire and others like it, making additional fire mitigation methods and policies even more important. Mitigation methods, such as prescribed burns, exist to help preempt fires and prevent them from burning out of control. When red flag warnings and burn bans are not enough to deter people from lighting

fires, or when natural events such as lightning strikes cause a fire, a prescribed burn can be the difference between a small manageable fire, and another catastrophe like the Marshall Fire. This is when controlled burns' role in maintaining healthy underbrush and preventing a build-up of fire fuels becomes even more important.

An additional reason that wildfire mitigation policies are becoming increasingly vital to life on the Front Range is that these wildfires are dangerous to fight. Oftentimes fire departments are too small or thinly spread across multiple counties, towns, or ranges to efficiently stop burns before they get out of hand (Town of Superior, n.d.-a). While these forces are highly trained to fight all types of fires, fire mitigation policy must be strengthened to support already overworked fire departments.

On top of overwhelming firefighters, these wildfires are incredibly expensive. Damages caused by WUI fires each year are massive, with California losing about $154.6 million a year in WUI structural damages alone (FEMA, 2021). The economic impact of wildfires is an important part of what drives the urgency of wildfire mitigation policy across the West, and economic factors – such as community taxes – can also be a factor in funding for mitigation policies.

Finally, current policy decision-making is largely fragmented across several government agencies, all widely spread out and governing vastly different areas, climates, and topographies. Wildfire prevention policy tends to be one-size-fits-all and very bureaucratic, both in prescription and in words, instead of focusing on unifying guidelines for policy and implementing individualized plans using the specialized understandings of Indigenous people and firefighters. All these factors work together to make wildfire prevention an uphill battle on an already-uneven playing field, with climate change, staffing, and vastly different topographies uniting to make the fight to prevent WUI fires more difficult.

My Project

For my thesis, I will be focusing on prescribed fire policy in the Front Range of Colorado, as the effectiveness of prescribed burns in this area is not fully understood. The Front Range runs vertically through almost the center of the state, along the interface between the Rocky Mountains, the Foothills, and the Plains. This is a popular area for settlement, meaning that many fires that occur in this area are WUI fires, and Boulder County is a prime example of concentrated settlement along the WUI. This makes it the ideal location on which to center my thesis research question: does the policy of controlled burns and other methods of fire prevention decrease the severity of wildland-urban interface wildfires, through ecological resilience and damage prevention, and how can the policy further accommodate the changing climate's indirect effect on wildfire prevalence?

In this paper, I will begin with background information, including a general history of fires in Colorado from 2000 to 2021, and current policy informers and enforcers. Next, I examine current and previous literature discussing this subject, specifically looking into unification and individualization of wildfire prevention policy because both factors allow fire departments and counties to work together (via unification) to form accurate and effective mitigation plans (via individualization). I will also consider how current policy is framed, specifically how extensive emphasis is placed on saving land and houses from fire, which inadvertently frames fire as the enemy. I suggest that this framing is not helpful when it comes to damage prevention and ecological resilience. From there, I will expand into my methods, and findings. I conclude that developing the most effective fire mitigation policy requires updates and adaptations to the current climate. This includes policy recommendations such as increased funding, expanding community outreach, and a diversification of the types of mitigation work used.

Extensive Background

Wildfires have become an impactful problem throughout the United States, and the world. A part of this issue is rising temperatures due to a changing climate; this causes conditions for wildfires to become more common and for fires to become less manageable. These conditions hold especially true in areas where humans and our settlements encroach upon natural spaces. Factors like landscaping, the density of houses, and the maintenance of the open space (undeveloped land) can all create ideal conditions for WUI fires (Calkin et al., 2014; Dictionary,com, n.d.).

Additionally, when it comes to mitigation, controlled burns act as both a fire-risk reducer and land restorer. Usually, they are set by firefighters, and heavily monitored throughout the time they are burning, or while the ground is still hot. While removing fire fuels like dry and dead grass and dead or damaged trees from the ecosystem, it also allows for seeds that require fire for germination to grow, producing fresh vegetation in place of dryer plants (US Forest Service, 2016).

Leadership in Policy

Current wildfire prevention policy is multifaceted, employing many different types of mitigation simultaneously, and in Colorado it is created and enforced by multiple branches of government, from the local to federal stage. Though this fragmentation of responsibility is common throughout the country, it does make crafting and enforcing uniform policy more difficult. Even within counties, fire departments' jurisdictions, terrain, and departmental preferences can make fire prevention policy's implementation difficult.

In Colorado, 70% of land ownership falls under public authority, divided up by many different bureaucratic organizations such as the Bureau of Land Management (BLM), US Forest Service, US Department of Fish and Wildlife, the National Park Service, the Department of Defense, state government, local governments, and other federal powers. The remaining 30% falls to private and tribal ownership (Colorado State Forest Service, n.d.).

With each federal and/or government entity taking ownership and responsibility for different swaths of land, fire mitigation policy implementation and control falls to different fire departments and authorities. While the Division of Fire Prevention and Control (a state level institution) is the one making plans for controlled burns, the people that implement the burns are local fire departments. Although this does mean that each pocket of land can be monitored with dedication and consistency, it also underscores that conflicting information transference is more likely to occur between the different levels of policy leaders and implementors.

Details Behind Policy Implementation

With multiple departments and organizations overseeing land conditions in Boulder County, prescribed burn implementation requires months of coordination, communication, and planning. For instance, it can take up to six months for a prescribed burn plan to be put into action (Colorado Division of Fire Prevention and Control, 2019). In this time, the weather patterns can change, drought conditions can worsen or improve, and other natural effects like atmospheric moisture could potentially render efforts for a controlled burn pointless or increasingly dangerous. The reason behind this is that controlled burns are, at their core, fires that can still become a raging wildfire given the right conditions (though this is rare). Whether or not they are intentionally set, fire is unwieldy and ignores borders and organizational

jurisdictions. In accounting for weather and ensuring that the conditions are safe for a fire, the risks of controlled burns are largely minimized.

Controlled burn plans are a very involved process, with every step handled by the Division of Fire Control and Prevention – a subset of the Colorado Department of Public Health. The process begins when an individual or group approaches the Division of Fire Control and Prevention with a project proposal for a controlled burn, including location and basic information about the area. Typically, this approach is motivated by concerns over dead grasses and other fuels on the ground. From there, the Division sends a team to examine the area for the prescribed burn, calling for certain analyses and data collection for the area. After this, a Prescribed Fire Plan is drafted, and then overseen and reviewed by multiple experts within the Division. If the Plan is approved, a Division administrator receives permits for both smoke/air quality monitoring and approvals, and fire control. After this, the plan receives approval and is ready to be implemented. According to the Colorado Department of Public Health Division of Fire Control and Prevention, this process takes at minimum 24 weeks (Colorado Division of Fire Prevention and Control, 2019).

The controlled burn implementation pathway is a long journey, and increasingly bureaucratic. This summary does not go into details about the steps that must be taken to modify or cancel plans for a controlled burn. Each of these extra considerations requires input and approval from higher-ranking fire officials, once again creating opportunities for miscommunication and complications in the implementation of controlled burns. Once a controlled burn has been approved, it must be implemented. In the case of the Forsythe II burn (occurring in Boulder County as early as April 2023), residents who had the potential to see the smoke were issued a notice of the burn's activity, as well as the timeline over which the burn

was expected to take place (US Forest Service, 2023). While the burn has not begun to take place, it demonstrates a perfect case of the logistical issues affecting implementation: a burn necessary to clean up fire fuels will span at least two typical fire seasons because of the increasing frequency of dangerous fire weather, and because of the importance of industry-wide cooperation and collaboration, particularly emphasizing the safety of those firefighters who are managing the burn. The implementation of controlled burns is complex, due to both the overlapping jurisdictions within counties, and because of the need to prioritize the safety of community members and firefighters during and after implementation.

Literature Review

Current research focuses primarily on how to completely prevent fire, and it also does not fully investigate the benefits of focusing on resiliency. There is a lack of focus on who drives and helps to shape policy changes, particularly when it comes to consulting street-level bureaucrats. My thesis focuses on the policy surrounding controlled burns, also referred to as prescribed burns, which are fires that take place under the observation of fire departments and firefighters and are started intentionally. Their purpose is to reduce wildfire fuels such as undergrowth and dried grasses under tightly controlled conditions before a wildfire breaks out (US Forest Service, 2016).

Additionally, very few researchers have considered Native Nations' knowledge and learning about how to properly implement controlled burns from their generational knowledge. This trend continues when it comes to speaking with firefighters about how they employ controlled burns, and how they understand and see fires occur. Further, while research about the communication that occurs between different government agencies is extensive, unified controlled burn policy is still a relatively new phenomenon, and as such does not have as much research surrounding its effectiveness. Based on current research, my thesis hopes to expand current understandings of who should be involved in policy, and how to improve policy's efficacy, particularly as it pertains to including knowledgeable experts' ideas and understanding the impacts of climate change.

Unification

In the previous century, prescribed burn policy was created by the federal government, specifically by the Department of the Interior's Forest Service (Davis, 2001), but the scope of

this approach was limited, given the federal government's inability to prescribe an individual plan for each state. As this approach has evolved, the implementation of prescribed burns has fallen mainly on state-level bureaucrats (Davis, 2001), allowing for a more specific and individualized approach to wildfire mitigation. The approach has proven to be far more successful, but still has not been expanded to all states. In expanding the approach to more states, a more top-level unified policy that allows for, or even requires, individualization on the ground would be beneficial for mitigation policy.

In Colorado, the differences between wildfire prevention policies across the state have been an issue in fire-fighting efforts for many years (Town of Superior, n.d.-b). The effort to both individualize and unify wildfire prevention policy is complex. Policy must be individualized since climates where WUI fires occur vary, so the prescribed burn policy for New Mexico must be different than that for Washington state. Oftentimes, policy must also vary within states due to different topography, weather patterns, and natural qualities. It must also be unified because, if the body of knowledge driving policy is the same across each state, and prioritizes street-level-bureaucrats' knowledge, policy would be more informed. There is a need to individualize the approach to mitigation policy, using and prioritizing SLB's knowledge, while unifying this approach on the upper bureaucratic levels.

Street Level Bureaucrats

SLBs are heavily influential when it comes down to community relations, and the understanding of policy on an intimate, personal level (Lipsky, 1980). They understand their field the most and understand when discretion would be the most effective course of action, and when it is not. This discretion is necessary and effective when it comes to the proper

enforcement of public policy. In the context of firefighting, discretion stems from firefighters' choices on how to fight a fire, where to concentrate efforts, where to let a fire burn, and how to do so safely and with the community in mind (Lipsky, 1980). These theories emerged from Michael Lipsky's work of understanding social theories, and why some forms of bureaucracy were effective while others were not. While he never explicitly mentions firefighters as SLBs, modern literature largely regards them with the same status as police officers who have been given this designation (Rauhaus, 2022).

There is limited information directly relating firefighters and street-level bureaucrats. However, in a paper by Beth M. Rauhaus, she examines how firefighters, as first responders, functioned during a community-driven COVID-19 vaccine roll-out. Through this investigation, she defines firefighters as street-level bureaucrats, and through this lens examines their benefits to the community that other organizations were not able to achieve. Additionally, because firefighters are first responders, they "serve as the frontline of public service delivery and are essential in government response to crises and emergencies" (Rauhaus, 2022). The definition of SLB has expanded to include firefighters, and not just in Rauhaus' work. Authors Anat Gofen and Gabriella Lotta also expand the definition of SLBs to include first responders, and those that take leading roles during crises as firefighters do (Gofen et al., 2021). While both studies take aim at SLBs during the height of the COVID-19 pandemic, they also reveal just how essential firefighters are to the functioning of a community. Another primary function of Lipsky's theory of the SLB is that they operate with a modicum of discretion, which is particularly exemplified through his example of police officers exercising their discretion when it comes to writing speeding tickets, and traffic stops in general (Lipsky, 1980). Fire is complex, and as such, implementing mitigation plans for dangerous wildfires cannot be dictated by a formula.

Firefighters' discretion in making informed decisions about where, how, and when to implement mitigation plans is therefore key.

Firefighters' discretion, combined with Lipsky's work defining SLBs, and the specialized knowledge they have of their communities and the roles they play, leads me to conclude that firefighters as SLBs are greatly underrepresented in fire prevention policymaking, especially as they are one of the primary groups of street-level bureaucrats who both work with the community to lessen fire risks, and who also improve community education surrounding fire safety.

Finally, while the context is slightly different, a previous study involving reducing the rates of urban fires employed firefighters within the bounds of the study, using them to inform their findings and their interactions with the public. The program centered on the installation of fire and smoke detectors in homes. When firefighters went out with the study, people were more receptive to their suggestions and insights. This program found that firefighters provided valuable insights and feedback for the policymakers and strengthened community ties (Frattaroli et al., 2012).

Broader Relational Considerations

Past fire mitigation policy has not included the input of actual policy-implementers, such as firefighters themselves (Miller, 2020), and instead has centered on county-level considerations like construction standards/incentives and individual responsibilities (Van Horn, 2013). This means that county policies provide rewards for how individuals construct their homes and how corporations build their businesses, instead of focusing on the recommendations of SLBs, or other individuals who understand how fire may move through the area. Additionally, in 2013

Senate Bill 13-083 passed, which granted the Colorado State Forest Service authority to conduct controlled burns on federal lands, despite it being a state-level government organization (Colorado Prescribed Burning Act, 2013). The Bill also adds another layer of jurisdictional considerations within burn implementation.

Another way to encourage fire mitigation falls on a more local level. Counties and states reward construction done with lower flammability materials by providing tax breaks and reliefs (Van Horn, 2013). While this shift in construction policy is important, the efforts of reducing the damages of wildfires cannot simply be placed on agencies that may not understand how fire would spread throughout their plot of land, or the dangers of their developments. In forgoing the context of local fire enforcement understanding, policy often misses the mark (US Department of Agriculture, 2016). and can no longer be implemented correctly, as seen in scenarios where community relations are violated while mitigation is attempted (Abrams et al., 2015). Without proper implementation, fire mitigation falls to the wayside, and can even backfire (US Department of Agriculture, 2016). In unifying the departmental and community approaches to controlled burns, fire mitigation efforts will be far stronger.

Additionally, there is a lack of consideration for the historic context of controlled burns. Native Nations have held controlled burns for many centuries before colonization and have passed down the generational knowledge of how those prescribed burns were conducted safely and effectively. Oftentimes, this would include knowledge on the optimal frequency of controlled burns, as well as their size and the length of time for which they were allowed to burn. This knowledge is referred to as Traditional Ecological Knowledge (TEK). Unfortunately, current policy rarely consults Native people, and so the generational knowledge of this practice is not utilized to fight the ecological crisis (Eisenberg et al., 2019). TEK alters ecosystems, and

when applied correctly during the appropriate time of year, properly reduces wildfire fuel, and protects native plant populations by activating seeds that require heat for germination. Because TEK encourages the land to burn controlled and consistently, instead of complete fire suppression and prevention, ecosystems that rely on fire, like that of the West, tend to thrive and burn less severely. These timing considerations make a measurable difference in wildfire damages, ecologically and economically (Eisenberg et al., 2019; Westerling, 2016).

Framing

A final aspect of my research centers on how wildfire prevention is implemented. Common, modern foci of prevention center on stopping WUI fires from occurring in the first place. However, this policy may be more harmful than helpful. After all, wildfire is a natural part of most ecosystems, particularly in the West. They are necessary to restore the soil and greenery to the land. Further, as wildfires become more common and damaging, their drivers become more common and entrenched in our ecology, so prevention becomes more difficult. Some authors argue that wildfire prevention is no longer focused on the correct aspect. Instead of centering prevention within wildfire policy, centering resiliency could be the most beneficial avenue (Calkin et al., 2014). In accepting wildfires as an eventuality, more work can be done to build structures to be more resilient, including changing regulations around building materials in WUI fire prone areas, improving landscaping to reduce the presence of easily flammable plants, and the early removal of dead or dying trees and other fire risks.

Arguments are made for prescribed burns to become more than a policy instrument as well. Heirs et al. argue that wildfire studies provide an optimal framework for studying controlled burns as a replication of wildfires (Hiers et al., 2020). In studying how controlled

burns move and what fuels they most effectively consume, the scientific understanding of wildfire can improve and influence future policy accurately. This would mean that, as policy implementation shifts towards controlled burns, they become more than just a fire mitigation practice; prescribed burns become a laboratory for WUI fires, improving and expanding the body of knowledge informing public policy.

Gaps in Current Research

The two gaps in the current literature that I am working to address are WUI fires and controlled burns' interaction, and the exclusion of street-level bureaucrats within modern policy. The limitations of current research in relation to my thesis center on the time between controlled burn and wildfire breakout, the frequency of controlled burns and the relationship between controlled burns and the accepted "natural" frequency of wildfires for the Front Range area, and finally, a lack of consideration for how street-level bureaucrats would choose to implement and maintain controlled burns.

On a normal plot of land, Colorado experiences wildfires every six to twenty years (Van Horn, 2013). This is a wide range of years, which can likely be attributed to climate change. While global warming's side effects are major contributors to wildfire conditions such as warm temperatures, lower air and soil humidity, and higher winds, it is not considered when investigating the natural regional frequency of wildfires. The data and information could be used to influence and inform policy choices when it comes to the frequency and size of controlled burns. Finally, in not interviewing local firefighters and utilizing TEK to inform policy, research behind the value street-level-bureaucrats could add to fire mitigation policies is lacking. Native organizers can provide policymakers with invaluable insights into the land, and how and when

fires should take place, and firefighters could provide similar information as they interact with the environment and fire conditions daily. Together, this intimate and extensive body of knowledge should be informing controlled burn policy. However, it is not.

My Focus

I plan to delve further into controlled burn policy, specifically expanding upon the work the Department of the Interior, Bureau of Land Management, and Bureau of Indian Affairs do to prevent wildfires along the Front Range of Colorado. Given this body of research, I plan to expand more on how prescribed burn policy can be improved through the study of fire boundaries, both prescribed and wild, within the wildland-urban interface, as well as expanding on the input of firefighters and Native people with this policy. In doing so, I hope to contribute to knowledge about how effective fire mitigation/controlled burn policy has been in the face of changing climates.

I will also deepen this body of knowledge for the Front Range of Colorado, specifically within Boulder County. In narrowing my search, my hope is that the data and information gathered from street-level bureaucrats will be more informative and applicable towards building fire mitigation policies along the Front Range because it is a high-risk, high-impact area for fire mitigation. The broader lessons may still have a wide-reaching impact on fire mitigation policy across the country, particularly as it pertains to contributing to the collection of knowledge surrounding fire mitigation.

Research Methods

Since my thesis focuses on the policy of prescribed burns, I investigated the frequency of Wildland-Urban Interface (WUI) fires along the Front Range of Colorado, particularly in Boulder County. While the Front Range extends up to Wyoming and down to Southern Colorado, this limited geographic scope is both useful for focusing my research and the area of deepest personal relationships to me.

To carry out this study, I compared prescribed burn data for this geographic area and investigated the frequency of fires in those same areas from six to twenty years after the prescribed burns have taken place (Davis, 2001). The time span of 6-20 years gave me a window with which to manage the amount of data I would be analyzing. In investigating this large span of years, I gathered data to see the patterns between prescribed burns, WUI fires, and a changing climate. Additionally, I also considered the perceived effects of climate change on these growing fires, as climate change worsens catalysts for massive wildfires. To do this, I performed a single-case study on WUI fire frequency throughout the Front Range of Colorado. In keeping my scope limited, any conclusions will be specific to Boulder County's Front Range and will be applicable and impactful in that area. However, this impact could be extrapolated to help inform the higher-level bureaucratic policy formation.

Quantitative Research Methods

Data was drawn from multiple government sites, including the Colorado Department of Public Health and Environment which provides data on all the prescribed burns in Colorado (Colorado Department of Public Health and Environment & Colorado Prescribed Fire Council, n.d.), and the MTBS fire viewer, which displays the fire boundaries, hot spots, and dates of fires

throughout the state of Colorado. My dependent variables were the locations of large fires, the average intensity of the fires that occur on that land, and those fires' proximity to the WUI. My independent variable was prescribed burns' locations within Boulder County. Using these designations, I was able to tell if the prescribed burns were having any effect on the land's probability of burning, and on the intensity of those potential wildfires. I was able to (indirectly) investigate the effects of a warming planet on WUI fire frequency. Should my findings reveal that the concentrations of prescribed burns and the locations of massive wildfire were largely overlapping, for example, the tentative conclusion would be that prescribed burns, as they are currently implemented, are not reducing the frequency of devastating WUI fires, nor decreasing wildfires' sizes or intensities.

To conduct this investigation, I utilized QGIS, a software that allows users to analyze publicly available geospatial information. Data downloaded from the MTBS fire viewer, as well as from the Colorado State Forest Atlas, were input into the system, which then creates a map of the area of interest. Through QGIS, I was able to find the burn probabilities and fire intensities for Boulder County (displayed on a categorized scale from 1 – least severe, to the highest number – most severe). The concentration of interaction between wildland and urban land was categorized in a similar way, with 1 being minimally concentrated and 7 being the most concentrated. Using these scales and the locations of the wildland fires and the controlled burns, I was able to investigate possible correlations between the two occurrences.

For this thesis, I preferred to have my investigation focus on a specific geographic area. This allowed me to provide specific feedback rather than sweeping generalizations that would not be applicable across the board due to geographic, topographic, and ecological differences. The overall outcome was the same: the policy recommendations and takeaways were applicable

in a limited geographic and bureaucratic area. To be broad and general with fire prevention policy was to assume the entire country has the same issues, and that is simply not true (Van Horn, 2013). While wider inferences were able to be made, in focusing on this smaller area I hoped to be able to investigate a high-risk area more closely.

Based on conclusions discussed in my previous sections, my hypothesis was that prescribed burns are not effective in reducing the size, intensity, and frequency of record-breaking WUI wildfires, and that the policy itself must evolve (or potentially be enforced more rigorously) (Wigglesworth, 2021) to have a more positive impact. An important consideration of this section is that wildfires are natural in the Western United States, and so any policy that focuses on complete prevention of fires will naturally be a failure. The ideal goal of prescribed burns then is to allow for more frequent and controllable wildfires to prevent devastating ones. There was some variation to this conclusion, including that as the frequency of fire weather and red flag days increased, the opportunity to perform prescribed burns lessened dramatically, thereby impacting the frequency of safe prescribed burns and the effectiveness of prescribed burns as a policy altogether.

Qualitative Research Methods

To gain more insight and a nuanced perspective, I sought to interview both firefighters and Native people, to learn their stories and experiences with prescribed burns, and how each of these groups of people would hope to see future policy shaped and changed to fight fires more effectively. Interviews took place over a two-week span from the 18th through the 28th of March 2023. The six firefighters I spoke with were from the Mountain Range Fire Rescue department. The department has a base in Superior, Colorado, and covers areas throughout Boulder County

and the Front Range. As they were on call during interview times, I interviewed them at their firehouse. Because this department oversees many different types of terrain, locations, and elevations (Town of Superior, n.d.-a), these firefighters were able to provide a varied and well-rounded view of fire prevention policy's strengths and weaknesses.[1] To prepare for interviews, I sent a rough outline of what I planned to discuss to the firefighters beforehand. This choice was to ensure that all firefighters were comfortable with the questions being asked, and generally knew what to expect.[2]

Regarding the interviewing of Native voices for this project, there are no recognized Native tribes located in Boulder County. There are, however, two recognized Native Nations[3] in Colorado, both located in the south of the state: the Ute Mountain Ute Nation and the Southern Ute Indian Tribe, sometimes referred to as the Four Corners tribes (Colorado Commission of Indian Affairs, n.d.). Both Nations, having a Council and a Chairman, would likely have people who would be able to provide insight into the issues of fire prevention through the eyes of Native people and knowledge. When I reached out to the Four Corners tribes, I received no response.

Because of the lack of response, I used secondary sources to investigate the impacts of Indigenous knowledge on fire mitigation. One such secondary source centered on Indigenous voices shaping and improving wildfire prevention policies. It focused on members of the Yurok Tribe in California's influence within Californian fire policies (Buono, n.d.). This Native Nation created the Indigeous People's Burning Network, and through that organization has experiece in

[1] I also ensured that interviews were held anonymously, with no personal or identifying information recorded, to encourage honesty and openness in the interviews.
[2] These questions (and those I had planned to ask Indigenous organizers) are in Appendix A.
[3] For this paper, I will be using the phrase "Native Nations," or "Native,", or "Indigenous", in place of "Indians," "Native Americans," or other terms. I made this choice because through my research I learned that the previous terms are often not the preferred way to refer to these groups of people.

policy and policy work, and would therefore have been able to provide insight and guidance for my research.

In attempting both a qualitative and quantitative analysis of this policy measure, I was able to investigate the data-based benefits of controlled burns using GIS software, comparing the locations of wildfires and controlled burns to burn probability and fire intensity data gathered by federal sources. I was also able to humanize the issue, bringing street-level bureaucrats and Native nations into the policy discussion to learn from their experience. The overall goal of fire prevention must be smaller, more frequent, controllable fires. Firefighters and Native organizers should have input on policy that aspires toward this goal. The street-level knowledge of firefighters, and the traditional knowledge maintained by Indigenous groups should come together to inform effective, adaptable wildfire mitigation policies.

Findings

Across the board, my findings were consistent with my predictions, as quantitatively, there was little to no correlation between where controlled burns were taking place, where fire risks were highest or lowest, or where burn probability was high or low. This was the case in open space and in the WUI. Additionally, interviews with firefighters revealed that, as expected, the impact of SLBs on policy is currently minimal and underused. Finally, though a newer avenue of fire mitigation, TEK showed the potential to restore cultural practices and the land.

Controlled Burns and Fire Risk Mitigation

My findings support my claim that controlled burns themselves are largely unhelpful when it comes to preventing devastating wildfires. Not only are the conditions for controlled

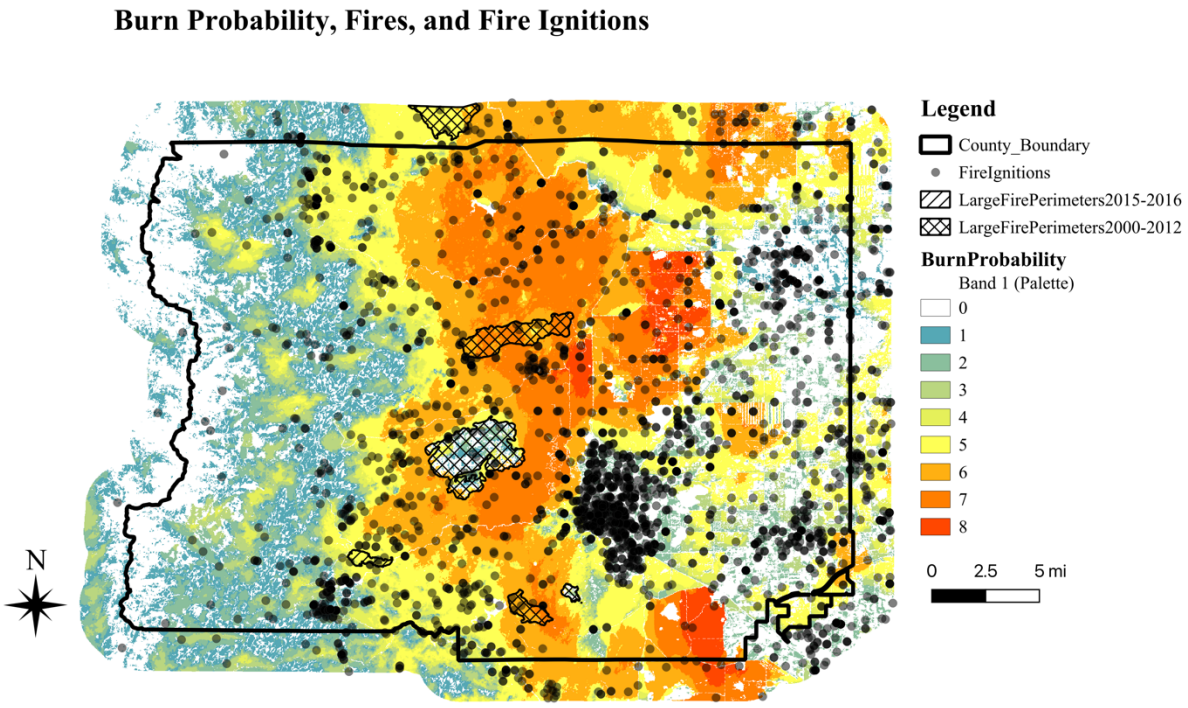

Figure 1 displays the relationships between burn probability, wildfire boundaries, and fire ignitions (controlled burns). Notably, ignitions do not largely occur in high burn probability areas.

burns difficult to achieve (ideal wind conditions, humidity levels, moisture on the ground), but they are also largely not effective. As displayed in Figures 1 and 2,[4] the locations of prescribed burns (referred to in the dataset as Fire Ignitions) are largely widespread, and while many occur

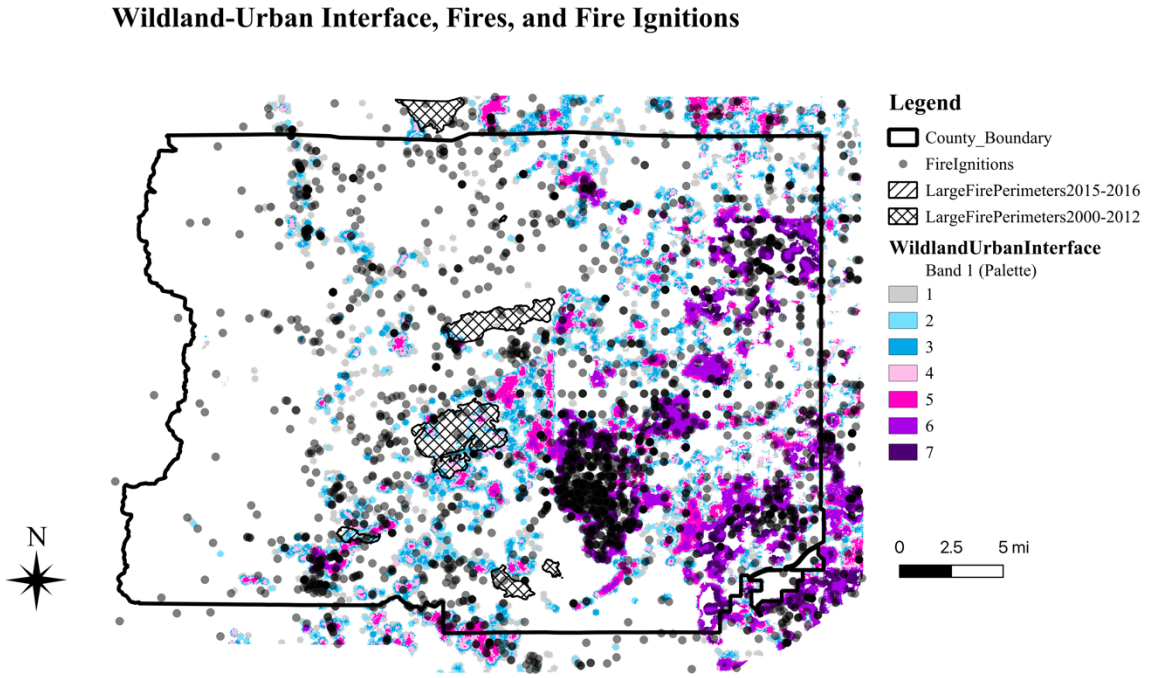

Figure 2 displays the WUI, large fire perimeters, and ignitions. Notably, fire ignitions are concentrated within the boundaries of the WUI, and not along its borders. Darker purple signifies a higher concentration of built-up land interacting with open space.

within the WUI, they do not seem to reduce burn probability. The concentrated locations of controlled burns are particularly clear in Figure 2, where the larger clusters of controlled burns are shown to be occurring in the urban space within the WUI boundaries, instead of along those borders where fire risk is particularly high.

Furthermore, firefighters emphasized the multifaceted risks that come along with implementing controlled burns, including risks to both social relationships and the health of the land. The primary concern expressed by these firefighters was that climate change has had a

[4] Additional maps in Appendix B.

major impact in fire conditions throughout the country, but particularly in the West. When talking about the evolving fire conditions, one firefighter noted the "craziness that there was ideal fire weather in March, as it is typically [Colorado's] snowiest month" (Firefighter 3, Anonymous Firefighters, personal communication, March 2023). The increasing commonness of fire weather, as observed by the firefighters, suggests that controlled burns are not just ineffective, but also no longer useful when it comes to mitigating risks from dangerous fires. This is because as the climate continues to change, the conditions that prevent controlled burns will become more and more common, so there are far fewer safe opportunities to conduct prescribed burns. All the while the need for fire, and the frequency of dangerous fires, will continue to increase.

A large part of this increasing fire risk and occurrence is also the bureaucratic process that surrounds implementing a controlled burn. While the long process exists to protect firefighters, civilians, and structures, it also allows for land conditions to worsen before the burn can be implemented. The firefighters I spoke with all agreed that shortening the process would make it difficult to simultaneously ensure the safety of those in the area around the burn. However, they were cautious about making any definitive statements about whether the six-month period between the burn request and implementation was an effective and efficient process. Despite the necessity for controlled burns, from interviews it seemed that the risks might outweigh the rewards of a greatly streamlined approval process. Overall, the controlled burns are already ineffective at preventing major wildfires due to the time span of the implementation process, and because of unwillingness of firefighters and communities to risk a controlled burn. There is also, now, a more pressing danger surrounding controlled burns. Despite the uses of controlled burns, they are a risky mitigation tool due to the changing climate, and both their

effectiveness and perception impact the inherent and perceived risks in using them to prevent dangerous wildfires.

Street-Level Involvement

Bureaucratically, fire departments are already an overworked and overwhelmed sector in public services. Not only do firefighters respond to local fire calls, but in the case of the firefighters I interviewed, they are also often deployed to other areas across the country and see fires across the West. Because of this widespread involvement dealing with a variety of fires around the country, their Chiefs trust their knowledge and listen to them when they see a plot of land with particularly high wildfire risks. Outside of informing their superiors, though, firefighters do not want to directly impact policy formation and implementation: "[Evergreen] had a prescribed burn, they had put it out, it had sat in the soil and just was hot for months, and then rekindled" (Firefighter 1, Anonymous Firefighters, personal communication, March 2023). For the firefighters, there are too many risks when it comes to implementing controlled burns. Therefore, burns as a mitigation method are used less locally, with the responsibility now falling more and more into the federal jurisdiction of fire prevention to implement burns on only federal lands.

Relationships between the communities and their fire departments could be affected by a prescribed burn gone wrong. Firefighters face funding losses if their policies become unpopular and could also risk losing social trust that has been built up over decades. Even when presented with a hypothetical scenario such as a policy analogous to doctors' medical malpractice insurance, they were not interested: "[it's] not even the financial liability of it, it's the public perception. We don't want [the residents] to hate us. We don't want them to be like, 'Oh, that's

the department that let that fire get out of control. So even if there wasn't financial liability, there's social liability" (Firefighter 5, Anonymous Firefighters, personal communication, March 2023). SLBs rely on community trust, especially first responders like firefighters. Should a burn go wrong, a firefighter's position as an SLB and as a firefighter could be at risk as they could lose community trust or community funding.

Additionally, firefighters are arguing for other methods of fire mitigation policy to be employed, particularly in high-risk areas where fire in general tends to elicit negative reactions. One firefighter brought forth the idea of conducting pile burns or burns where cut down trees from the forest are piled up and are not burned until there is snow on the ground surrounding the piles. In addition to reducing the risks of dry land allowing fire to spread faster, it also means that those fires are surrounded by moisture, reducing the risk of an out-of-control fire. With this method, the land is cleared, and high-risk, dry vegetation is burned, but the risk of a large fire is small (Jenkins et al., 2014). Firefighters have the agency to choose their preferred mitigation methods, and they use their specialized knowledge to protect their jurisdictions in the best ways they know.

Finally, firefighters encourage those who live at the direct border between wildlands and urban centers to focus not on the aesthetic nature of their land, and instead on prioritizing fire risk reduction. Many people love living in the mountains, and this can cause problems when it comes to fire mitigation. One firefighter noted that "everyone wants to live out there. You know, where we live, everyone loves the mountains, it's pretty out there. They want to have their space and their forest" (Firefighter 1, Anonymous Firefighters, personal communication, March 2023). Because people focus on their properties and the aesthetic desires they hold for their "ideal"

living conditions, fire mitigation falls second. Forests become denser, and more dangerous in the eyes of fire risks.

For on-the-ground firefighters, the risks of implementing controlled burns largely outweigh the benefits. The risks of destroying community relations, of spending too much money and human resources on an increasingly risky mitigation method, and the existence of other, safer mitigation methods means that firefighters largely oppose the use of controlled burns to clear forests and rejuvenate lands. For these firefighters, the ability of the community to invest in their mitigation plans, sustain that investment, and trust their fire departments (community buy-in) is instrumental in successful wildfire mitigation. They argue that community buy-in is far more impactful than other mitigation methods they use, as it takes much of the risk from their hands and can lead to more sustainable mitigation efforts.

With community (and bureaucratic) buy-in, WUI fires' impacts can be lessened. One firefighter, using anecdotal evidence from Summit County, talks about a land survey that led to the construction of a fire break, where trees were felled, and land was cleared at the border between a community and the wildland that surrounded it:

> The Buffalo Mountain Fire [happened] right in Silverthorne right next to this beloved, big neighborhood and the wilderness. And a few years before that the Forest Service had gone through and done a ton of fire mitigation and created a fire break between where the forest came down and where these big communities were with these multifamily complexes. And at first people were so angry because they're cutting down the trees, and there's this open space, and they thought "it's kind of an eyesore." But then I can remember four years ago that fire happened, and [the fire break] stopped it, and it gave [us time to get] air tankers in there. And it worked. No one died, nobody was hurt. (Firefighter 4, Anonymous Firefighters, personal communication, March 2023)

While many residents contested the construction of the break, there was enough buy-in for its construction and maintenance. When a fire came through the area years later, the fire break held. No structures were lost, no lives were lost, and the community was far more receptive to fire

mitigation ideas, with some openly admitting "'I was wrong. I fought against this when it was happening. But it proved [itself], it saved homes to save lives'", according to a firefighter who witnessed the interaction (Firefighter 4, Anonymous Firefighters, personal communication, March 2023). While the minimal community buy-in was instrumental at originally constructing the break, the increased buy-in from seeing its success meant that firefighters could continue their work with more support from the community, increasing their work's effectiveness and reach.

At the end of the day, firefighters are a community with a wide depth and breadth of knowledge that ought to be included in mitigation policy, but too often is not. As I discussed in my Literature Review, the inclusion of SLBs – such as firefighters – means that specialized knowledge can be used to inform policy more accurately. They know the barriers to mitigation the best, as well as the land, the people in their communities, and how to garner more support for important mitigation methods.

When I asked what one firefighter thought the biggest barrier was to controlled burn implementation, and fire mitigation in general, they thought for a moment. Eventually, the response was: "I think the hardest thing is that internally, the citizens that see us and wonder why we're not doing certain things, people don't understand the fires are good" (Firefighter 2, Anonymous Firefighters, personal communication, March 2023).

Traditional Ecological Knowledge

Firefighters are not the only ones with specialized knowledge of fire mitigation. Native nations have also developed, through centuries, specialized and local knowledge of the lands where they live (TEK). While I was unable to contact anyone at the Indigenous People's Burning

Network, there is research that supports the claim that while traditional burnings may not necessarily restore the ecosystem, they still aid in its rebalancing. Ways of measuring ecosystem regrowth, such as the population of indigenous plants, were introduced which provided a way to show that these prescribed burns were in fact effective at restoring parts of the forest that received the treatment (Wells, 2014). For this group, fire was a good, restorative force, not a destructive, feared hazard.

After a particularly difficult fire season, Native people from the Karuk tribe in Northern California had seen fire fuels build up and overwhelm healthy forests and began calling for changes in how controlled burns and other mitigation methods were used on their lands. This encouraged the government to include them in drafting burn plans for 8,000 acres, which "[drew] heavily on the ancestral knowledge of Karuk tribal members." In addition to bringing back native plants, those prescribed burns allowed firefighters to successfully defend a collection of homes on the Butler Flat in California but reducing the amount of easy-to-light fuel on the ground. That fuel reduction was what made it possible to fight the fire successfully (Wells, 2014).

In employing TEK to fire-dependent and -adapted lands, both cultural practices and ecosystem needs have been maintained successfully. Across Arizona, Alaska, and Oregon, recently deployed, TEK-driven fire mitigation plans implementing controlled burns have helped to prevent massive devastation from wildfires. TEK-informed prescribed burn policies have also helped maintain cultural practices that are threatened by climate change, such as weaving hazel baskets (U.S. Fish & Wildlife Service, 2022). In Alaska, research involving reaching out to Native people to gain understanding about TEK, and comparing that knowledge to an already-existing Fire Management Plan (FMP) found that while there were overlaps between TEK and

the FMP, TEK allowed for a more finely detailed understanding of the ecosystem, its fire risks, and how best to mitigate those issues (Ray et al., 2012). The study also found that there were in some cases conflicting information between information gathered through TEK and the FMP, but also that TEK can work to replace or strengthen ecological knowledge and inform burn policy when scientific knowledge excludes place-based information about the lands and ecosystem.

The projects working to include TEK are new and developing, meaning that their true and full effects may not be visible until years in the future. They are also not widespread. This also means that consistent, widely-agreed-upon knowledge surrounding TEK, and fire mitigation is difficult to find. Even so, these programs' early success is a positive sign pointing towards the benefits of TEK in forming and implementing fire mitigation policies, and because of this I can reach a provisional conclusion that by including the knowledge held by Native and Indigenous communities, the effectiveness of prescribed burns' implementation would likely improve, and that subsequently the risks of out-of-control wildfires would be lessened.

Limitations and Future Research

For my thesis, the biggest limitation was that I was unable to contact people at the Indigenous People's Burning Network. Because of this, my research relied on already-existing scholarship and second-hand research to inform my opinions of whether TEK has an important and relevant impact on today's controlled burn polices, and I was unable to investigate the implications first-hand. Further, as the inclusion of TEK in fire mitigation is largely a new field, there is not a lot of new research, which makes it difficult to draw conclusions that could be broadly applicable to the current situation.

Additionally, I was limited geographically, which impacted the generalizability of my data and conclusions. While this is less of an obstacle, and means that my conclusions are strong, for Boulder County, it also means that they are difficult to expand towards other counties, states, and ecosystems.

In the future, were this project to continue, I would expand my scope to extend past the boundaries of Boulder County. In expanding northward and southward, I would be able to further investigate the challenges of overlapping jurisdictions and their effects on mitigation policy. Additionally, I would be able to explore the complexities of different biomes and their effect on fire risks and risk management, as well as SLBs' perceptions of fire mitigation and controlled burns. I would also emphasize the work that the California-based Indigenous People's Burning Network does, as well as their analogous organizations in states such as Alaska, Arizona, and Oregon. I would also be able to formulate more original research in that area to demonstrate the positive effects the inclusion of TEK can have on both wildfire mitigation policy and on the ecosystems themselves.

Policy Recommendations

The policy recommendations I have are threefold: increase community awareness of wildfire mitigation – including education on alternative and additional mitigation measures to prescribed burns, a careful streamlining of the procedures to implement a prescribed burn, and an emphasis on the inclusion of TEK and the specialized knowledge of SLBs. Most importantly, I do recommend that prescribed burns continue. While firefighters and communities take on large amounts of risk when a burn is implemented, the benefits to the land are also incredibly valuable, both culturally and environmentally. An emphasis on the inclusion of TEK in current policy to ensure that controlled burns continue is particularly important, as cultural practices and the health of the ecosystem should be prioritized while maintaining the safety of firefighters and communities.

Community Awareness and Buy-in

Previously, I discussed how effective fire mitigation policy both needs and fosters community buy-in. Unfortunately, when events such as the Marshall Fire occur, community buy-in for controlled burns will not receive support. The trauma associated with fire makes it incredibly difficult to rally support behind a plan that utilizes fire. In its place, other methods of fire mitigation must be used to protect the structures that exist along the WUI. Very few communities currently have functioning programs to raise awareness about fire risks in their vicinity, and those that do are no longer free. While some communities in Boulder County are Firewise communities (communities that receive special training and information meant to mitigate fire risks), that designation is not widespread and requires yearly time and/or monetary

contributions (National Fire Protection Association, n.d.). Because of this, it is difficult for all communities to stay involved, up-to-date, and protected against devastating wildfires.

As the lack of community buy-in and awareness greatly affects the effectiveness of existing mitigation policy, I propose that the most important change in policy would be an increase in support towards fire departments and at-risk communities on the federal level. This increased support would take many forms. One way to increase support is to grow partnerships with organizations that provide fire-risk surveys for homeowners. Even more importantly, starting community-wide education programs for community members and residents to learn about wildfire and its benefits could foster increases in community buy-in for prescribed burns, and fire awareness in general. Instead of seeing fire as the enemy, these programs would work to educate the community about fire's benefits.

There are two major drawbacks to this policy recommendation. The first is that it requires massive amounts of funding. Fire departments are largely funded by tax revenue from their communities, so smaller departments that serve more rural areas tend to, therefore, operate on a volunteer basis. Without addendums that would ensure equitable distribution of funds for community projects, this policy would not be successful. A community should not face higher fire risks simply because they do not have adequate funding. Second, it requires a preexisting amount of community buy-in because without buy-in, programs to survey homes or increase education about fire will receive no attention and be dead in the water. While disasters tend to foster this buy-in on a broader-policy scale (such as, "Yes! Let's prevent fires"), people tend to forget, and still be averse to mitigation methods that emulate or mimic the disaster.

When it comes to community buy-in, SLBs would be on the front line, garnering support and trust from the communities they serve. The need for community buy-in is universal across

public policy, and fostering an environment where that can occur is difficult. House surveying and education programs would be a major improvement for community buy-in, centering the issue of wildfire mitigation and reminding those who live in the community of the risks, without placing too much of an additional burden on firefighters, who already do most of the mitigation work.

Expediting the Timeline

As I discussed in my Findings section, the effectiveness of controlled burns on wildfires is somewhat limited by the time frames in which controlled burns must take place. The implications behind this are that while areas across the county rely on controlled burns to maintain ecological health, the land does not receive them in a timely manner, leading to the increasingly common wildfire conditions. Policymakers must take the bureaucratic timeline into consideration when designing future wildfire prevention policy and examining the effectiveness of current policy.

Because of these policy implications, a promising recommendation would be to streamline the process of implementing a controlled burn. In place of the current 24-week timeline, it could be beneficial to reduce the time allotted for land surveys, and the amount of time given for the report to be written. These small changes could allow for more frequent controlled burns, without decreasing the number of overseers on the program, to maintain safety while also expediting the practice. These burns would then mimic the healthier, more frequent fires that benefit the West's ecosystem.

However, there are barriers to this policy recommendation. The primary one is safety concerns, both for people, and for the landscape around the areas where controlled burns are

occurring, especially as the time for on-the-ground research would be shortened. To minimize these concerns, having smaller controlled burns, more frequently, could potentially reduce the risks of controlled burns growing out of control. Additionally, having mass-alerts go out to inform community members of controlled burns, or another way of sharing information on controlled burn schedules, would be a good way to also ensure public awareness, increasing public safety as well.

In general, this case demonstrates the problems behind heavily bureaucratic processes, and how they often fail to adapt to climate change, and other quickly evolving situations. Because of bureaucratic restrictions (taking at least 24 weeks to implement one burn), should the wind change suddenly on the day of the burn, after the burn has started, there is no way to adjust the plan outside of stopping the burn entirely. While wildfire prevention policy is often incredibly area-specific, the general move to streamline the long, involved processes behind the policy is something all policymakers can benefit from. In situations requiring fast action, it is often necessary to react, instead of making bureaucratically informed decisions.

TEK and Controlled Burns

The inclusion of TEK in fire mitigation policy is new, and not yet widespread. While Native nations have a wealth of historical knowledge about their surrounding ecosystems, this body of knowledge is often not reflected in policy. Because of this, policy tends to center around science-based ideas, instead of place-specific measures, leading to a buildup of fire fuel such as dead grasses, tree branches, and tumbleweeds. Policymakers should make sure to include every voice that has valuable knowledge, not just the predominant voices, by reaching out to those

populations that are known to have highly specialized knowledge, and a vested interest in ensuring the resiliency of the ecosystem.

The best policy recommendation I can provide related to TEK is to follow in the footsteps of other states such as California, Arizona, Alaska, and Oregon, and introduce a new wildfire prevention policy that considers the historic knowledge held by Native nations in the Front Range. Part of this would include outreach to those communities, and the creation of committees and organizations to make sure those voices are heard in policy. After growing these communities and groups, the next step would be to include the groups in policy discussions and formation, as has happened in California, Oregon, Alaska, and Arizona.

One potential drawback could be the difficulty of forming groups and committees that would help inform policy. The knowledge Native nations hold is important and valuable, but the time commitments and energy expended would be large. Additionally, even though this policy has worked in four states so far, that does not necessarily mean it will work in the Front Range. It would be a risk to invest in this policy that may not work. Even though there are drawbacks, the benefits largely outweigh these risks. Supporting and encouraging a healthy ecosystem means that catastrophic fires would be less likely to occur, and everyone would benefit.

The case of TEK and wildfire mitigation, like other policy issues, centers on who is most impactful and has important knowledge that will positively impact the policy's success. In moving to include TEK in wildfire mitigation policy formation, more informed voices with valuable information can influence the environment. As climate change worsens, informed, tried-and-true responses to maintain the health of our ecosystems will become increasingly important.

Conclusion

Wildfire is a necessity in the Colorado Front Range. It restores the land by burning dry and dead plants and grasses, and it rejuvenates the soil and allows for culturally significant plants and practices to be maintained. Historically, it has maintained the forests and open spaces, allowing new plants to grow where older ones were dying. Unfortunately, as recently as 2022, devastating wildfires have drastically impacted social and political receptions towards fire. Instead of being something to live with, it became something to fear.

In my thesis, I used a mix-methods approach to demonstrate that while currently ineffective at reducing the risks of massive wildfires, controlled burns provide much-needed enrichment to ecosystems and improve the resiliency of cultural practices, particularly those of Indigenous nations. Through data analysis and interviews, I discovered that both climate change and the social fear of fire are driving factors behind why controlled burns as a mitigation method lack efficacy. Through streamlining the controlled burn approval process, improving education and community resiliency, and integrating the opinions of SLBs and TEK gathered by Native nations into controlled burn policy, we can improve our resilience towards the expensive and dangerous phenomenon of wildland-urban interface wildfires.

Adaptation and resilience are becoming key in every facet of life as climate change worsens, and policy largely fails to keep up. The Marshall Fire was just one example of the devastating effects of climate change; it created the perfect storm for a small grass fire to grow into the monstrous firestorm I experienced. If policy can adapt and can begin to focus more on flexibility, education, and acceptance, those disasters can become less frequent. We can learn to live with fire, but only if our policies evolve to match the need of the communities they protect.

Bibliography

Abrams, J. B., Knapp, M., Paveglio, T. B., Ellison, A., Moseley, C., Nielsen-Pincus, M., & Carroll, M. S. (2015). Re-envisioning community-wildfire relations in the U.S. West as adaptive governance. *Ecology and Society*, *20*(3). https://www.jstor.org/stable/26270246

Anonymous Firefighters. (2023, March). *Firefighter Interviews for Thesis Project* [Personal communication].

Booth, M. (2022, January 23). *Data may be Colorado's best bet to mitigate increasing wildfire risk on the Front Range*. The Colorado Sun. http://coloradosun.com/2022/01/23/data-sensors-colorado-wildfire-prevention/

Britannica. (n.d.). *Front Range*. Retrieved December 7, 2022, from https://www.britannica.com/place/Front-Range-mountains-Colorado

Buono, P. (n.d.). *Quiet Fire*. The Nature Conservancy. Retrieved October 10, 2022, from https://www.nature.org/en-us/magazine/magazine-articles/indigenous-controlled-burns-california/

Calkin, D. E., Cohen, J. D., Finney, M. A., & Thompson, M. P. (2014). How risk management can prevent future wildfire disasters in the wildland-urban interface. *Proceedings of the National Academy of Sciences*, *111*(2), 746–751. https://doi.org/10.1073/pnas.1315088111

Colorado Bureau of Land Management. (n.d.). *Colorado Fire Information*. Retrieved April 7, 2023, from https://www.blm.gov/programs/public-safety-and-fire/fire-and-aviation/regional-information/colorado

Colorado Commission of Indian Affairs. (n.d.). *Tribes*. Retrieved November 25, 2022, from https://ccia.colorado.gov/tribes

Colorado Department of Public Health and Environment & Colorado Prescribed Fire Council. (n.d.). *Colorado Prescribed Fire Data*. Retrieved October 3, 2022, from http://www.coprescribedfire.org/corxdata/

Colorado Division of Fire Prevention and Control. (n.d.). *Historical Wildfire Information*. Retrieved November 14, 2022, from https://dfpc.colorado.gov/wildfire-information-center/historical-wildfire-information

Colorado Division of Fire Prevention and Control. (2019, January). *Fire Implementation Planning Guide*. https://csfs.colostate.edu/wp-content/uploads/2019/12/2019_3-20_2019_DFPC_RX_Fire_Implementation_Planning_Guide.pdf

Colorado State Forest Service. (n.d.). *Colorado Land Ownership*. Colorado State Forest Service. Retrieved November 25, 2022, from https://csfs.colostate.edu/colorado-forests/colorado-land-ownership/

Davis, C. (2001). The West in Flames: The Intergovernmental Politics of Wildfire Suppression and Prevention. *Publius*, *31*(3), 97–110.

Dictionary,com. (n.d.). *Open Space*. Retrieved April 13, 2023, from https://www.dictionary.com/browse/open-space

Eisenberg, C., Anderson, C. L., Collingwood, A., Sissons, R., Dunn, C. J., Meigs, G. W., Hibbs, D. E., Murphy, S., Kuiper, S. D., SpearChief-Morris, J., Little Bear, L., Johnston, B., & Edson, C. B. (2019). Out of the Ashes: Ecological Resilience to Extreme Wildfire, Prescribed Burns, and Indigenous Burning in Ecosystems. *Frontiers in Ecology and Evolution*, *7*. https://www.frontiersin.org/articles/10.3389/fevo.2019.00436

FEMA. (2021). *Analysis of NFIRS Incidents in the Wildland Urban Interface*.

Frattaroli, S., McDonald, E. M., Tran, N. T., Trump, A. R., O'Brocki, R. C. I., & Gielen, A. C. (2012). Igniting Interest in Prevention: Using Firefighter Focus Groups to Inform Implementation and Enhancement of an Urban Canvassing Program. *Journal of Public Health Management and Practice*, *18*(4), 382. https://doi.org/10.1097/PHH.0b013e31823e96e9

Gofen, A., Lotta, G., & Marchesini da Costa, M. (2021). Working through the fog of a pandemic: Street-level policy entrepreneurship in times of crises. *Public Administration*, *99*(3), 484–499. https://doi.org/10.1111/padm.12745

Hiers, J. K., O'Brien, J. J., Varner, J. M., Butler, B. W., Dickinson, M., Furman, J., Gallagher, M., Godwin, D., Goodrick, S. L., Hood, S. M., Hudak, A., Kobziar, L. N., Linn, R., Loudermilk, E. L., McCaffrey, S., Robertson, K., Rowell, E. M., Skowronski, N., Watts, A. C., & Yedinak, K. M. (2020). Prescribed fire science: The case for a refined research agenda. *Fire Ecology*, *16*(1), 11. https://doi.org/10.1186/s42408-020-0070-8

Jenkins, M. J., Runyon, J. B., Fettig, C. J., Page, W. G., & Bentz, B. J. (2014). Interactions among the Mountain Pine Beetle, Fires, and Fuels. *Forest Science*, *60*(3), 489–501. https://doi.org/10.5849/forsci.13-017

Lipsky, M. (1980). Street-Level Bureaucrats as Policy Makers. In *Street Level Bureaucracy* (pp. 13–25). Russell Sage Foundation. https://www.jstor.org/stable/10.7758/9781610447713.6

Miller, R. (2020). Prescribed Burns in California: A Historical Case Study of the Integration of Scientific Research and Policy. *Fire*, *3*(3), Article 3. https://doi.org/10.3390/fire3030044

National Fire Protection Association. (n.d.). *Firewise Communities*. Ready for Wildfire. Retrieved March 31, 2023, from https://www.readyforwildfire.org/prepare-for-wildfire/firewise-communities/

Phillips, N. (2022, October 27). Marshall fire losses now expected to exceed $2 billion—Making it the 10th costliest wildfire in U.S. history. *The Denver Post*. https://www.denverpost.com/2022/10/27/marshall-fire-property-losses-value/

Rauhaus, B. M. (2022). Public Service Motivation of Street- Level Bureaucrats Amidst the COVID-19 Pandemic: An Analysis of Experiences in Implementation of an at-Home Vaccination Program. *State and Local Government Review*, *54*(1), 82–91. https://doi.org/10.1177/0160323X221079242

Ray, L. A., Kolden, C. A., & Chapin, F. S. (2012). A Case for Developing Place-Based Fire Management Strategies from Traditional Ecological Knowledge. *Ecology and Society*, *17*(3). https://www.jstor.org/stable/26269081

SENATE BILL 13-083, no. 13–083 (2013). http://www.leg.state.co.us/clics/clics2013a/csl.nsf/billcontainers/5F5B370100DCF8DC87257A8C00507309/$FILE/083_enr.pdf

The Denver Post. (2016, April 30). *Colorado's most expensive wildfires (insured losses) – The Denver Post*. https://www.denverpost.com/2012/06/25/colorados-most-expensive-wildfires-insured-losses/

Town of Superior. (n.d.-a). *Mountain View Fire Rescue Substation*. Retrieved November 9, 2022, from https://www.superiorcolorado.gov/departments/public-safety/rocky-mountain-fire-authority

Town of Superior. (n.d.-b). *Open Space Management Plan*. 43.

US Department of Agriculture. (2016, July 15). *Public Fire Information Websites*. US Forest Service. https://www.fs.usda.gov/science-technology/fire/information

US Department of Commerce, N. (n.d.). *Red Flag Warning*. NOAA's National Weather Service. Retrieved December 7, 2022, from https://www.weather.gov/mqt/redflagtips

US Fire Administration. (2022, June 8). *What is the WUI?* U.S. Fire Administration. https://www.usfa.fema.gov/wui/what-is-the-wui.html

U.S. Fish & Wildlife Service. (2022, June 10). *Working Together*. US Fish and Wildlife Service. https://www.fws.gov/story/2022-05/working-together

US Fish and Wildlife Service. (n.d.). *Traditional Ecological Knowledge Fact Sheet*. FWS.Gov. Retrieved November 13, 2022, from https://www.fws.gov/media/traditional-ecological-knowledge-fact-sheet

US Forest Service. (2016, December 6). *Prescribed Fire*. US Forest Service. https://www.fs.usda.gov/managing-land/prescribed-fire

US Forest Service. (2023, March 31). *Forsythe II Prescribed Burn Could Take Place Early April*. https://www.fs.usda.gov/wps/portal/fsinternet3/cs/detail/arp/news-events/

Van Horn, M. (2013). The Importance of Community in Wildfire Prevention and Hazard Mitigation. *Natural Resources & Environment*, *27*(4), 3–6.

Wells, G. (2014). *Traditional Ecological Knowledge: A Model for Modern Fire Management?* (No. 20; Fire Science Digest).

Westerling, A. L. (2016). Increasing western US forest wildfire activity: Sensitivity to changes in the timing of spring. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1696), 20150178. https://doi.org/10.1098/rstb.2015.0178

Wigglesworth, A. (2021, November 8). *Prescribed burns are key to reducing wildfire risk, but federal agencies are lagging*. Los Angeles Times.

https://www.latimes.com/california/story/2021-11-08/us-forest-service-struggles-to-complete-prescribed-burns

Appendix A

Interview Questions for Firefighters:

- Can you describe your position in relation to fire prevention policy in the Colorado Front Range?
- For as long as you've been in your position, have you seen any changes in WUI fire frequency, conditions? What have you seen/learned?
- Do you get a say in the policy, how it's shaped, and what it focuses on?
    - Do you want this impact on policy implementation?
    - How do you get this impact on prescribed burn policy?
- How do you think the current method of approaching and implementing controlled/prescribed burns works?
    - How could it be improved?
- How are prescribed burns' effectiveness measured in your line of work?
- Do you see street-level-bureaucrats such as yourself having an impact in the policy, and in helping lower the frequency of conditions for WUI fires?
- How does climate change affect your ability to conduct controlled burns with the frequency Colorado policy demands?
    - Have you reached the quota for controlled burns every year? What factors prevent you from meeting this quota? Or what factors allow you to reach this quota?

Interview Questions for Native Organizers:

- How does your organization work to ensure Native voices are heard in fire mitigation policy?
- What are your primary concerns when it comes to fire mitigation policy?
- What do you think of current fire mitigation policy across the Western United States?
    - Areas of improvement, successes, failures?
- How do Native organizers get an input on fire mitigation policy, specifically controlled burns?
    - How bureaucratic is the process?
- Does this process have breakdowns or failures?
    - Given a brief rundown of Colorado burn plans, and the steps that go into it, does it seem effective?
    - Any improvements?
- How does climate change affect your ability to influence policy surrounding controlled burns?
    - Does it affect your ability? Or has it made it easier/made politicians more receptive towards your ideas?
- How do you view Traditional Ecological Knowledge and its impact in your efforts to ensure controlled burn policy reflects the needs of the people who appreciate the outdoors/rely on its resources?

Appendix B

This appendix displays maps and images that were not included in the Findings section, but I feel are interesting and wanted to include. They display further relationships between fire risks and conditions within Boulder County.

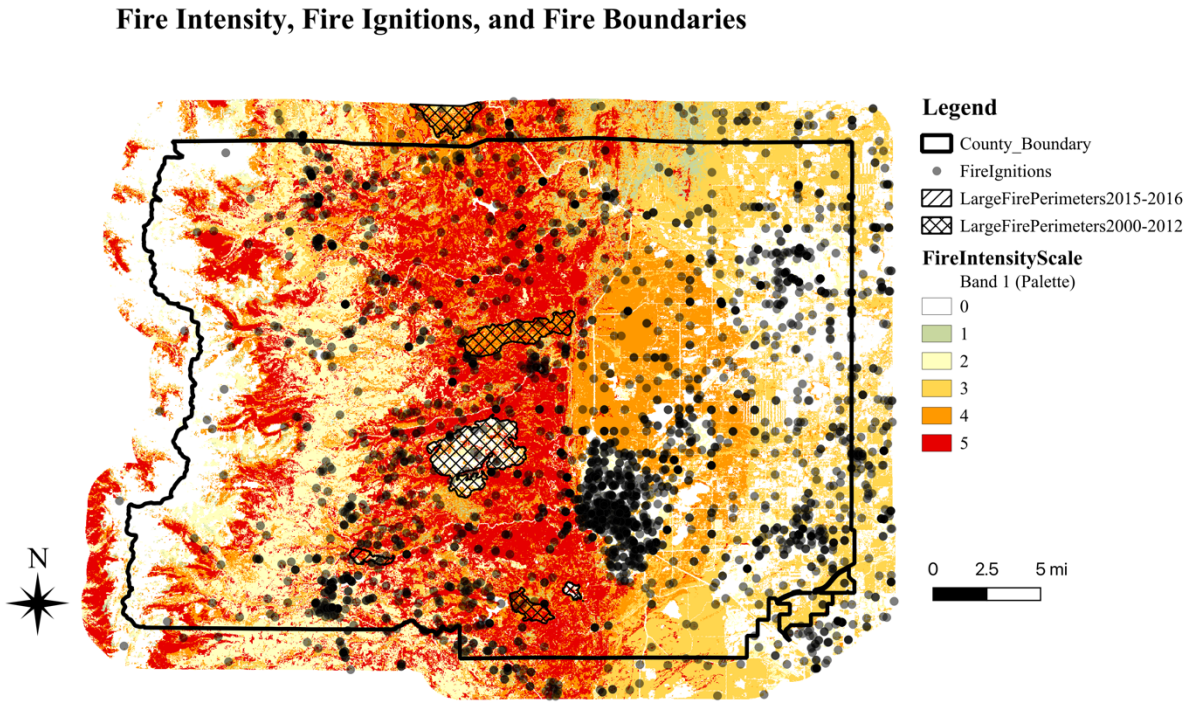

Figure 3 shows burn intensity (averaged over the years and with fuel considered) compared with large fires and controlled burns. Majority of controlled burns are not where burn intensity is highest.

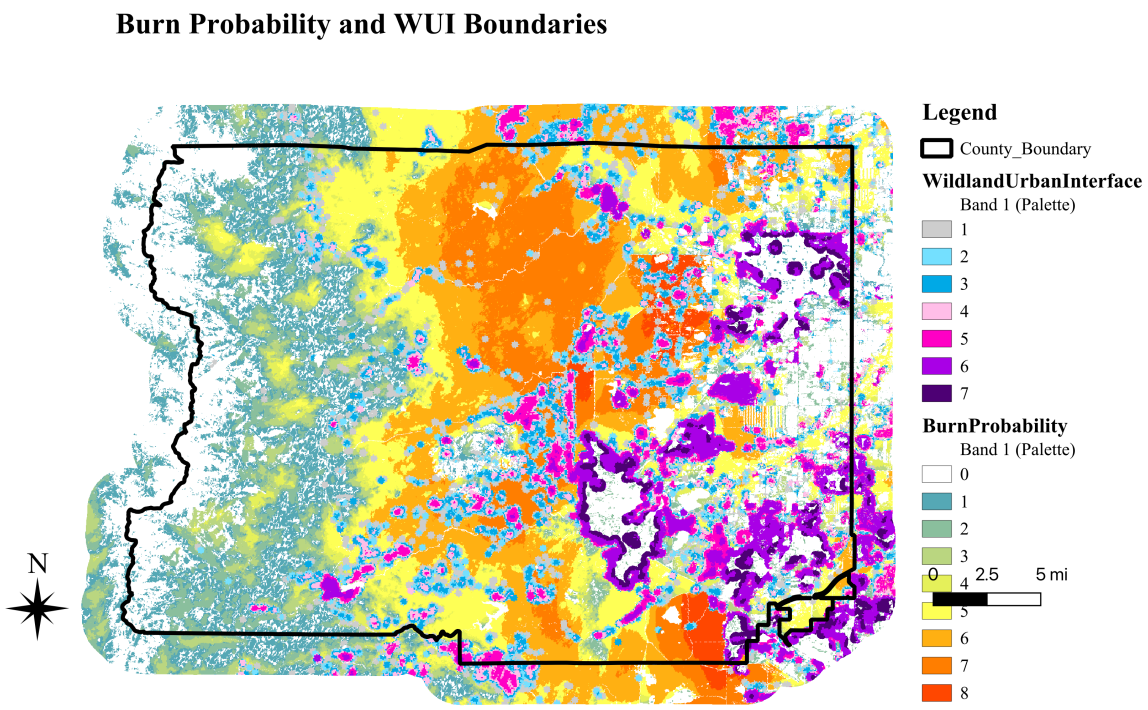

Figure 4 shows burn probability and the WUI boundaries, with burn probability higher near the majority of WUI interactions. Particularly in the North- and South-east, burn probability is very high along the WUI boundaries, demonstrating the need to focus on this area.

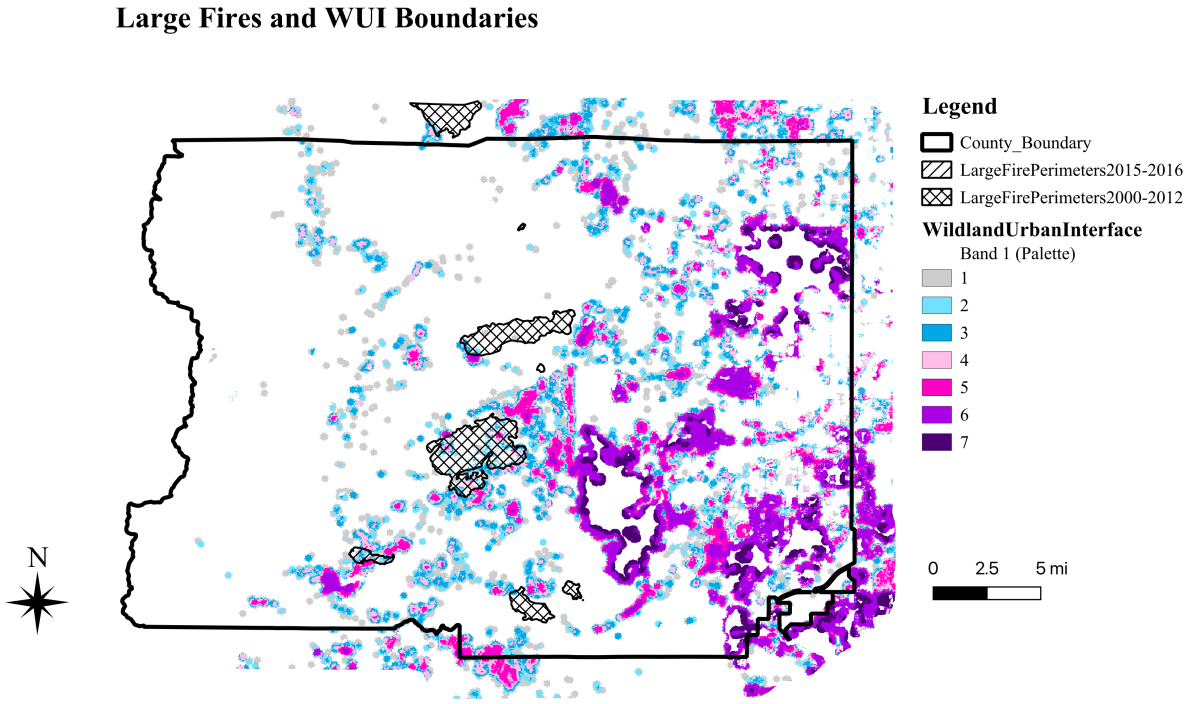

Figure 5 shows large wildfire boundaries (with available data) and the boundaries of the WUI, most large wildfires also overlap with the WUI, meaning structures were threatened and/or burned during these fires.